PROPOSED TOTAL MAXIMUM DAILY LOAD (TMDL)

For
Fecal Coliform
In
Bessey Creek
(WBID 3211)

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AWT	Advanced Waste Treatment
BMP	Best Management Practices
BPJ	Best Professional Judgment
CFS	Cubic Feet per Second
DEM	Digital Elevation Model
DMR	Discharge Monitoring Report
EPA	Environmental Protection Agency
F.A.C.	Florida Administrative Code
GIS	Geographic Information System
HUC	Hydrologic Unit Code
LA	Load Allocation
MGD	Million Gallons per Day
MOS	Margin of Safety
MPN	Most Probable Number
MS4	Municipal Separate Storm Sewer Systems
NASS	National Agriculture Statistics Service
NLCD	National Land Cover Data
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
OSTD	Onsite Sewer Treatment and Disposal Systems
PLRG	Pollutant Load Reduction Goal
Rf3	Reach File 3
RM	River Mile
STORET	STORage RETrieval database
TMDL	Total Maximum Daily Load
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WBID	Water Body Identification
WLA	Waste Load Allocation
WMP	Water Management Plan
WWTF	Wastewater Treatment Facility

SUMMARY SHEET

Total Maximum Daily Load (TMDL)

1. **303(d) Listed Waterbody Information**
   State: Florida
   Major River Basin: St. Lucie

Impaired Waterbodies for TMDLs (1998 303(d) List):

WBID	Segment Name and Type	River Basin	County	Constituent(s)
3211	Bessey Creek	Southeast Coast	St. Lucie	Fecal Coliform

2. **TMDL Endpoints (i.e., Targets) for Class III Waters (fresh and marine):**
   Fecal Coliform: 400 MPN/100mL

3. **Fecal Coliform Allocation:**

WBID	WLA FL0043214	WLA_{MS4}	LA	TMDL	Reduction
3211	38 percent reduction	38 percent reduction	38 percent reduction	38 percent reduction	38%

4. **Endangered Species (yes or blank): Yes**

5. **EPA Lead on TMDL (EPA or blank): EPA**

6. **TMDL Considers Point Source, Nonpoint Source, or both: Both**

7. **NPDES Discharges to surface waters addressed in TMDLs:**

Facility Name	NPDES No.	Facility Type	Receiving Stream
Martin County Utilities (MCU) Consolidated Reuse System (South County) in Port Salerno	FL0043214	Municipal Reuse System	Roebuck Creek and Bessey Creek
Martin County MS4	FLR04E013	MS4	multiple
City of Stuart MS4	FLR04E031	MS4	multiple
Sewall's Point MS4	FLR04E044	MS4	multiple

TOTAL MAXIMUM DAILY LOAD (TMDL)
FECAL COLIFORM IN BESSEY CREEK WATER BODY ID

1. INTRODUCTION

Section 303(d) of the Clean Water Act requires each state to list those waters within its boundaries for which technology based effluent limitations are not stringent enough to protect any water quality standard applicable to such waters. Listed waters are prioritized with respect to designated use classifications and the severity of pollution. In accordance with this prioritization, states are required to develop Total Maximum Daily Loads (TMDLs) for those water bodies that are not meeting water quality standards. The TMDL process establishes the allowable loadings of pollutants or other quantifiable parameters for a waterbody based on the relationship between pollution sources and in-stream water quality conditions, so that states can establish water quality based controls to reduce pollution from both point and non-point sources and restore and maintain the quality of their water resources (USEPA, 1991).

The State of Florida Department of Environmental Protection (FDEP) developed a statewide, watershed-based approach to water resource management. Under the watershed management approach, water resources are managed on the basis of natural boundaries, such as river basins, rather than political boundaries. The watershed management approach is the framework DEP uses for implementing TMDLs. The state's 52 basins are divided into 5 groups. Water quality is assessed in each group on a rotating five-year cycle. The Group 2 basin is shown in Figure 1 and includes the St. Lucie and Loxahatchee River Basins. The St. Lucie and Loxahatchee Basins encompass many square miles. To provide a smaller-scale geographic basis for assessing, reporting, and documenting water quality improvement projects, the FDEP subdivided the Group 2 area into smaller areas called planning units. Planning units help organize information and management strategies around prominent subbasin characteristics and drainage features. To the extent possible, planning units were chosen to reflect subbasins that had previously been defined by the South Florida Water Management District (SFWMD). The St. Lucie and Loxahatchee Basins contain eight planning units: C-25/Basin 1, North St. Lucie, C-24, C-23, South St. Lucie, C-44, Loxahatchee, and Coastal. Water quality assessments were conducted on individual waterbody segments within planning units. Each waterbody segment is assigned a unique waterbody identification (WBID) number. Waterbody segments are the assessment units or polygons that have historically been used by the FDEP to define waterbodies in their biannual inventory and reporting of water quality to EPA under Section 305(b) of the federal Clean Water Act. The same WBIDs are also the assessment units identified in the FDEP's biannual lists of impaired waters submitted to EPA as part of their reporting under Section 303(d) of the Clean Water Act.

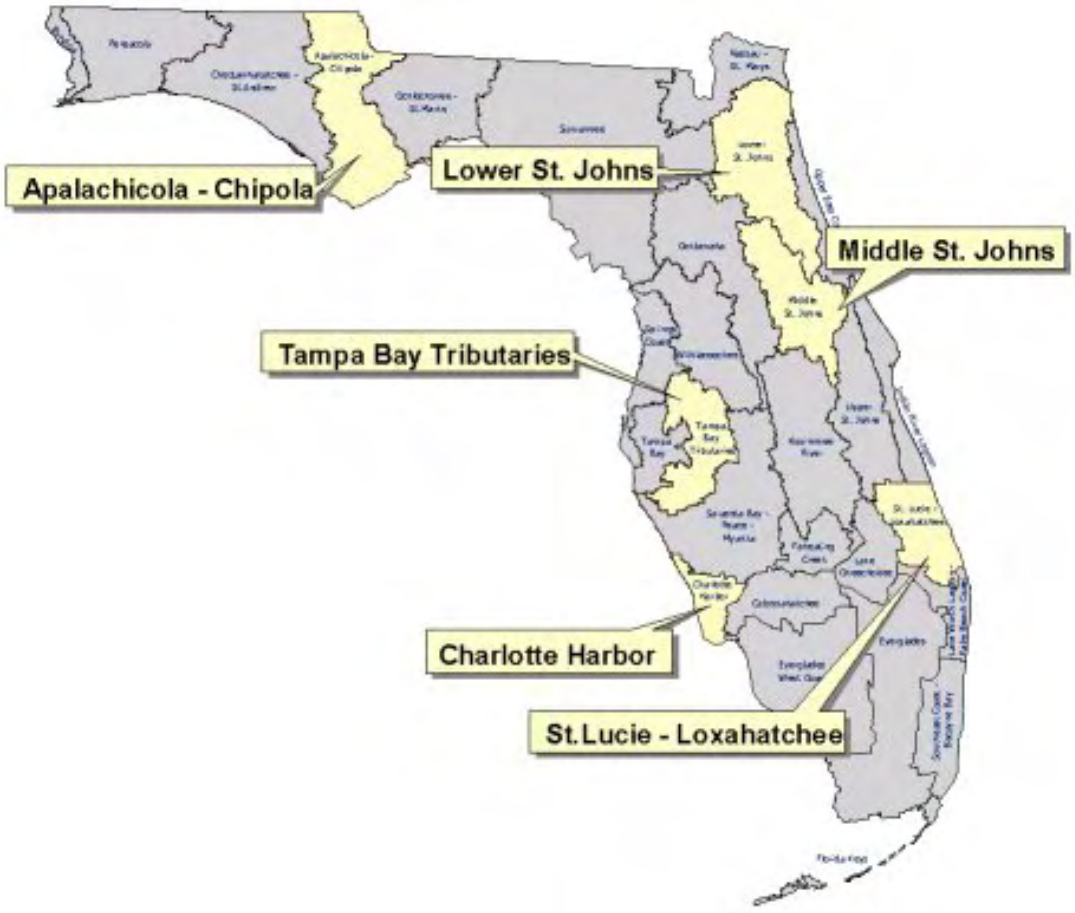

Figure 1: FDEP Group 2 River Basins

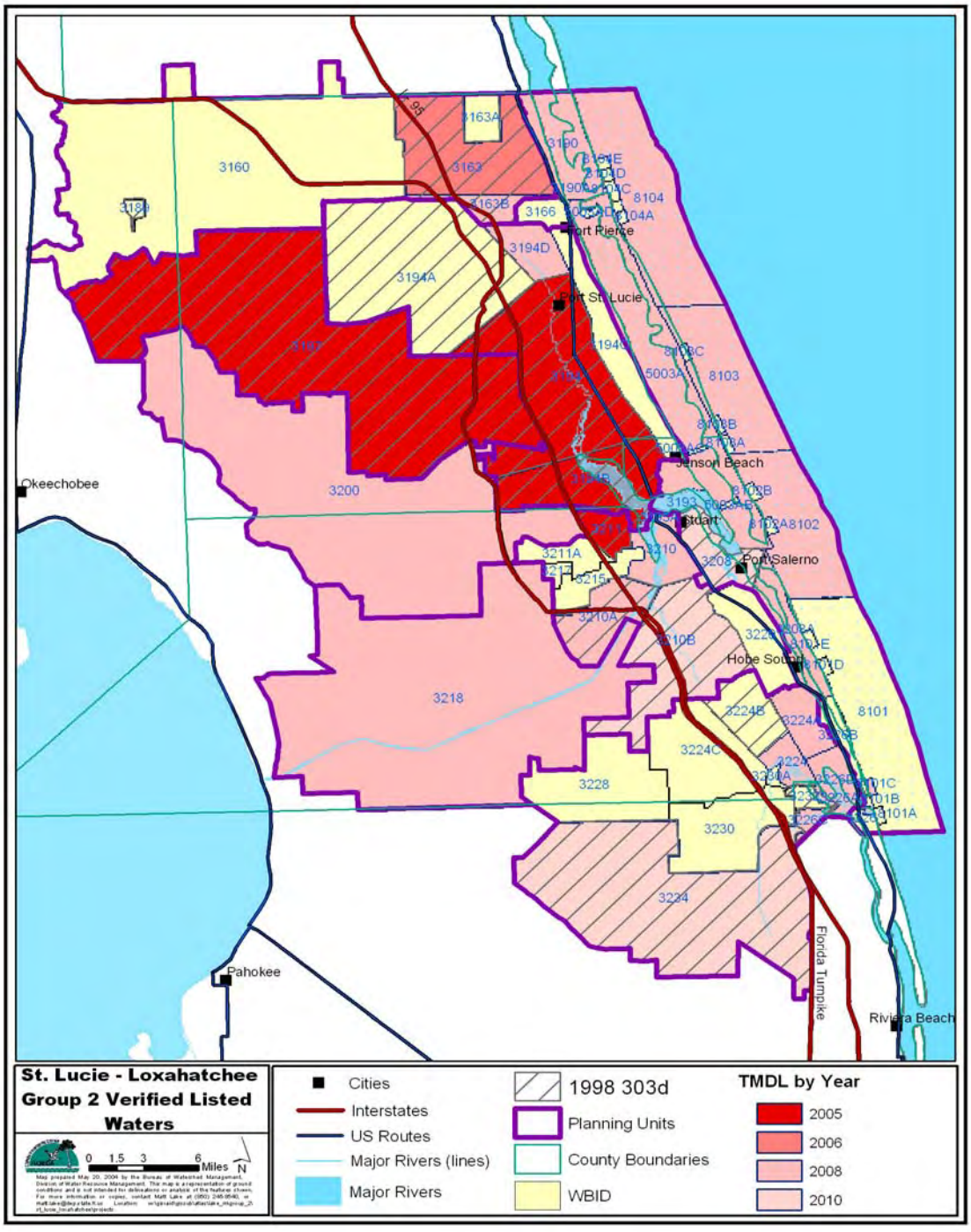

Figure 2: St. Lucie / Loxahatchee River Basin. WBID 3211 is on the 1998 303(d) list for Fecal Coliform.

2. PROBLEM DEFINITION

Florida's final 1998 Section 303(d) list identified WBID 3211 in the St. Lucie River Basin as not supporting water quality standards (WQS) due to coliform bacteria. After assessing all readily available water quality data, EPA is responsible for developing a fecal coliform TMDL in WBID 3211, Bessey Creek. The location of WBID 3211 is shown in Figure 2. The TMDL addressed in this document is being proposed pursuant to EPA commitments in the 1998 Consent Decree in the Florida TMDL lawsuit (Florida Wildlife Federation, et al. v. Carol Browner, et al., Civil Action No. 4: 98CV356-WS, 1998).

WBID 3211 is designated as a Class III marine water. The designated use of Class III waters is recreation, propagation and maintenance of a healthy, well-balanced population of fish and wildlife. Class III waters are further categorized based on fresh or marine waters. Water quality criteria for fecal and total coliform do not vary between Class III fresh or marine waters.

3. WATERSHED DESCRIPTION

The following information is from the FDEP, 2003, Basin Status Report for St. Lucie and Loxahatchee. In the St. Lucie Basin, most of the land in the non-coastal areas is used for the production of citrus and beef cattle. The extensive network of canals that drains these agricultural areas transports storm-water runoff containing nutrients, sediment, bacteria, and other pollutants. These reach the natural drainage-ways (such as the North and South Forks of the St. Lucie River) and ultimately the St. Lucie Estuary and the South Indian River Lagoon. The St. Lucie Canal (C-44), the inland waterway that connects Lake Okeechobee to Florida's east coast, transports regulated releases of water from Lake Okeechobee and runoff from agricultural areas within the C-44 basin. Other major canals also transport storm-water from inland agricultural areas to the estuary. Canals C-23 and C-24 discharge water into the North Fork of the St. Lucie River and the C-25 Canal discharges to the Indian River Lagoon. These canals transport loads of nutrients and eroded sediment to the estuary and slugs of fresh water that create fluctuations in estuarine salinity levels. Urban and residential areas continue to expand in the coastal areas, with polluted urban storm-water runoff and seepage from septic tanks also contributing to the water quality problems in streams and canals. As a result, parts of the St. Lucie Estuary (SLE) appear to be impaired by nutrients, copper, and low levels of DO. Nutrient loads, salinity fluctuations, and accumulations of sediment stress the estuarine ecology. Other evidence of impairment was gathered for the SLE segments in a FDEP South East District biological survey (Graves et al., June 2002). Sediment accumulation, decline of sea-grasses and oysters, algal blooms, fish kills, and low diversity of benthic macroinvertebrates in the SLE comprise this body of evidence.

WBID 3211 is in the South St. Lucie planning unit of the St. Lucie Basin. The South St. Lucie planning unit lies in Martin County and includes most of the city of Stuart (in the southeastern part), plus portions of Palm City, Coral Gardens, Gomez, and Hobe Sound. This planning unit includes the natural drainage of the South St. Lucie River and includes several SFWMD

subbasins. These include the Tidal St. Lucie subbasin which includes the South Fork of the SLE, Manatee Creek Basin, Bessey Creek drainage, and Danforth Creek. It also includes the eastern terminus of canal C-44 (St. Lucie Canal) through which flow is regulated by the S-80 structure. Bessey Creek (3211), is a tributary to the SLE. This segment of Bessey Creek exceeds the Planning List criteria for DO per the IWR and is also on the 1998 303(d) list for coliform, nutrients, BOD, and DO. Recent FDEP monitoring data not included in the preliminary assessment indicate that 3211 is also potentially impaired for nutrients based on chlorophyll-a detections. Another segment of Bessey Creek (3211A) does not have sufficient data to be assessed. There are four freshwater stream segments in the planning unit that were evaluated, South Fork of the St. Lucie River south of the estuary (3210B), Basin 6 (3215), Basin 5 (3217), and Basin 2 (3220). The South Fork segment is potentially impaired, exceeding the Verified List criteria for biology and for DO. It is also on the 1998 303(d) list for a variety of parameters including coliform, nutrients, BOD, and DO. Basins 6, 5, and 2 (3220) do not have sufficient data to be assessed.

Wetlands comprise approximately 10 percent of this planning unit and upland forests cover approximately 25 percent of the area. The South Fork of the St. Lucie River and the Atlantic Ridge (in the southern part of this planning unit) are designated as a Save Our Rivers (SOR) priority natural areas for acquisition. It is through the C-44 Canal discharge into the South Fork of the St. Lucie River that many of the ecological impacts to the SLE have been felt. The massive surges of fresh water have severely stressed the entire ecosystem of the estuary, dramatically reducing the salinity level at times. The sediment load carried by C-44 has blanketed the bottoms of the estuary, the river, and its tributaries and depleted the natural benthic habitat. Urban and agricultural canals that discharge to the estuary are in some respects equally to blame for the decline in the estuary (St. Lucie River Issues Team Report, October 1998).

Under the Feasibility Study, approximately 17,143 acres of pastureland in the Pal-Mar tract will be converted to a Natural Storage and Treatment Area. This area is in both the South St. Lucie (Tidal St. Lucie) and C-44 planning units. By plugging canals that would otherwise discharge directly to C-44 and the South Fork and by taking land out of agricultural land use, this component will improve water quality and reduce the sediment load to the river and estuary. Issues Team plans include three significant urban stormwater retrofit projects underway in the Stuart area. These include the Poppleton Creek, Fern Creek, and Frazier Creek projects that incorporate detention and treatment of urban stormwater before it reaches the St. Lucie River and the estuary. Approximately 25 percent of this planning unit is used for agricultural purposes, primarily in improved pastureland. Like elsewhere, implementation of best management practices (BMPs) to reduce polluted runoff from cow-calf operations are important to the improvement of water quality in the receiving waterbodies.

WBID 3211 is highly developed with 51 percent residential and 18 percent commercial and industrial. The land cover distribution for these and other cover types is shown in Table 1. The WBID includes Bessey Creek and its tributaries from the Bessey Creek mouth at the St. Lucie River extending upstream about 5 kilometers.

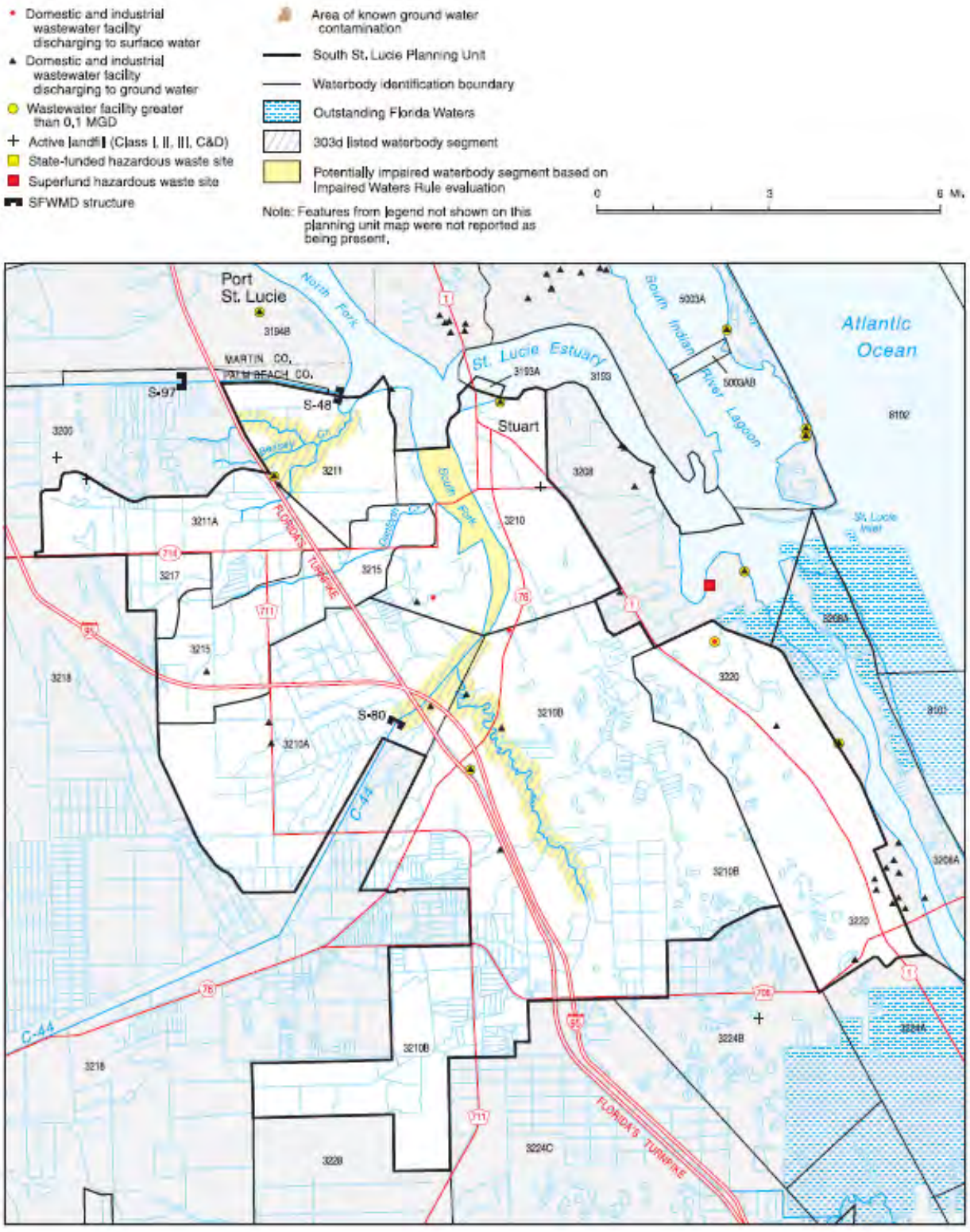

Figure 3: South St. Lucie Planning Unit

Table 1: Land Cover Distribution for WBID 3211 in acres and percentage.

Land Cover	Acreage	Percentage
Residential (1100-1390)	1823	51%
Commercial, Industrial, Public (1400, 1500, 1800)	665	18%
Agriculture (2000 series)	123	3%
Rangeland (3000 series)	46	1%
Forest (4000 series)	326	9%
Water (5000 series)	247	7%
Wetlands (6000 series)	286	8%
Barren & Extractive (7000, 1600)	2	0%
Transportation & Utilities (8000 series)	83	2%
TOTAL (acres)	3599	

4. WATER QUALITY STANDARD FOR FECAL COLIFORM BACTERIA AND TARGET IDENTIFICATION

The water quality criteria for protection of Class III waters are established by the State of Florida in the Florida Administrative Code (F.A.C.), Section 62-302.530. The individual criteria should be considered in conjunction with other provisions in water quality standards, including Section 62-302.500 F.A.C. [Surface Waters: Minimum Criteria, General Criteria] that apply to all waters unless alternative or more stringent criteria are specified in F.A.C. Section 62-302.530.

Fecal coliforms are a subset of the total coliform group and indicate the presence of fecal material from warm-blooded animals. Total coliform bacteria generally indicate the presence of soil-associated bacteria and result from natural influences on a water body such as rainfall runoff as well as sewage inflows. The most probable number (MPN) or membrane filter (MF) counts per 100 milliliter (ml) of fecal coliform bacteria shall not exceed a monthly average of 200, nor exceed 400 in 10 percent of the samples, nor exceed 800 on any one day. Monthly averages shall be expressed as geometric means based on a minimum of 10 samples taken over a 30-day period. The geometric mean criteria reflect chronic or long-term water quality conditions whereas the 400 and 800 values reflect acute or short-term conditions.

The target for this TMDL is the daily 800 counts per 100 ml and the “not to exceed 400 in 10 percent of the samples” criteria, since enough monthly data was not collected to evaluate the monthly average 200 criteria. When flow data are available in the WBID, the fecal coliform TMDLs are expressed as daily loads in units of MPN per day. The fecal coliform TMDLs are also expressed in terms of the percent reduction required to achieve water quality standards. When flow data are not available in the WBID or due to hydrologic and/or geologic conditions it is not possible to estimate flow (i.e., tidal influence or karst geologic formation), the TMDLs are expressed only as percent reductions.

It is appropriate to use the more stringent of the acute criteria for fecal coliform TMDL

development as the data indicates violations of the standard are typically related to storm events, which are short-term in nature. Violations of the chronic criteria are typically associated with point sources or non-point source continuous discharges (e.g., leaking septic systems) and typically occur during all weather conditions. Targeting the acute criteria should be protective of the chronic criteria.

5. WATER QUALITY ASSESSMENT

To determine the status of surface water quality in Florida, three categories of data – chemistry data, biological data, and fish consumption advisories – were evaluated to determine potential impairments. The level of impairment is defined in the Identification of Impaired Surface Waters Rule (IWR), Section 62-303 of the Florida Administrative Code (F.A.C.). The IWR defines FDEP's threshold for identifying water quality limited WBIDs to be included on the state's 303 (d) list. In addition, all waters on the 1998 303 (d) list that were not de-listed remain on the current 303 (d) list and require TMDLs. The WBID 3211 is on FDEP's planning list for fecal coliform bacteria. EPA assessed this WBID and concluded that it is impaired, and a fecal coliform TMDL must be developed.

FDEP maintains ambient monitoring stations throughout the basin. All data collected at monitoring stations within the impaired WBID are used in the analysis. Table 2 provides a list of the monitoring stations, and shows that only five samples were collected and each was from a different station.

Table 2: Monitoring Stations used in the Development of this Fecal Coliform TMDL

Station ID	Station Name	Number of Observations	Result (counts per 100 ml)
21FLA 28010031	ST LUCIE RIV AT MOUTH OF BESSEY	1	10
21FLA 28010047	BESSEY CRK AT MURPHY RD	1	650
21FLA 28010098	AT SPILLWAY IN C23	1	75
21FLA 28010176	MOUTH OF BESSEY CRK PRIOR JCT WITH C23	1	80
21FLA 28010213	BESSEY CREEK AT END OF NAVIGABILITY	1	420

Table 3. Summary of Fecal Coliform Monitoring Data in WBID 3211

Number of Samples	30-Day Geometric Mean[1]	% Samples > 400 (MPN/100ml)	% Samples > 800 (MPN/100ml)	Minimum Concentration (MPN/100ml)	Maximum Concentration (MPN/100ml)
5	N/A	40%	0%	10	650

Notes:
1. N/A = not applicable since less than 10 samples were collected within a 30-day period to evaluate criteria.

6. SOURCE ASSESSMENT

An important part of the TMDL analysis is the identification of source categories, source subcategories, or individual sources of coliform bacteria in the watershed and the amount of pollutant loading contributed by each of these sources. Sources are broadly classified as either point or non-point sources.

A point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Point source discharges of industrial wastewater and treated sanitary wastewater must be authorized by National Pollutant Discharge Elimination System (NPDES) permits. NPDES permitted facilities discharging treated sanitary wastewater or stormwater (i.e., Phase I or II MS4 discharges) are considered primary point sources of coliform.

Non-point sources of coliform are diffuse sources that cannot be identified as entering a waterbody through a discrete conveyance at a single location. These sources generally, but not always, involve accumulation of bacteria on land surfaces and wash off as a result of storm events. Typical non-point sources of coliform include:

- Wildlife
- Agricultural animals
- Onsite Sewer Treatment and Disposal Systems (septic tanks)
- Urban development (outside of Phase I or II MS4 discharges)

A geographic information system (GIS) tool, was used to display, analyze, and compile available information to characterize potential bacteria sources in the impaired WBID. This information includes land use, point source dischargers, soil types and characteristics, population data (human and livestock), and stream characteristics.

6.1 Point Sources

In this planning unit, there are 19 permitted wastewater treatment facilities, 11 treating domestic

wastewater, and 8 treating industrial wastewater. Only 3 of these facilities discharge to surface water. The Martin County Utilities (MCU) Consolidated Reuse System (South County) in Port Salerno, NPDES FL0043214 is a wastewater reclamation/reuse facility and is only allowed to discharge intermittently during periods of heavy rainfall under its NPDES permit. This is the only permitted wastewater facility discharging to surface water that would impact the waters of WBID 3211. This reuse facility receives treated effluent from several wastewater treatment plants and is permitted to discharge to golf course ponds and land application sites. Only intermittent discharges from these golf course ponds are permitted. The MCU Martin Downs Wastewater Treatment Facility in Palm City, included under the MCU permit, has a design capacity of 2 mgd but does not discharge to surface water. There are 2 closed solid waste landfills in this planning unit. According to FDEP records, in the South St. Lucie planning unit, there are 8 dry cleaning facilities and approximately 90 reported discharges from petroleum facilities. There are no state-funded or federal (National Priorities List [NPL]) hazardous waste cleanup sites or delineated ground water contamination areas in this planning unit. Figure 3 shows permitted wastewater treatment facilities, landfills, and delineated areas in the South St. Lucie River planning unit.

Municipal Separate Storm Sewer Systems (MS4s) may also discharge bacteria to water-bodies in response to storm events. Large, medium, and small MS4s serving populations greater than 50,000 people, or with an overall population density of 1,000 people per square mile, are required to obtain a NPDES storm water permit. There are three MS4 permits in Martin County; Martin County (FLR04E013), City of Stuart (FLR04E031), and Sewall's Point (FLR04E044).

6.2 Non-point Sources

Runoff from urban and agricultural areas impacts water quality in Bessey Creek and its tributaries. Predominant land uses in the South St. Lucie planning unit are agriculture (34 percent) and urban/built-up (26 percent). The primary agricultural land use is improved pasture (25 percent of planning unit). The predominant land use within the urban/built-up category is low-density residential (approximately 10 percent).

6.3 Wildlife

Wildlife deposit bacteria in their feces onto land surfaces where it can be transported during storm events to nearby streams. Bacteria load from wildlife is assumed background, since the contribution from this source is small relative to the load from urban and agricultural areas. Water fowl (e.g., egrets, ducks, wood storks, herons) often frequent storm-water ponds. Depending on the number of birds, the contributions of fecal coliform could result in stream concentrations above the criteria.

6.4 Agricultural Animals

Agricultural animals are the source of several types of coliform loadings to streams, that impact

water quality. This source includes agriculture runoff from pastureland and cattle in streams. The land use within the impaired WBID is only 4 percent agricultural and rangeland (Table 1), so this landuse likely does not discharge a significant amount of the bacteria load.

The USDA National Agricultural Statistics Service (NASS) compiles Census of Agriculture data by county for virtually every facet of U.S. agriculture (USDA, 2002). The "Census of Agriculture Act of 1997" (Title 7, United States Code, Section 2204g) directs the Secretary of Agriculture to conduct a census of agriculture on a 5-year cycle collecting data for the years ending in 2 and 7. Livestock inventory from the 2002 Census of Agriculture reports for Martin County is listed in Table 4. Cattle and calves are the predominate livestock. Confined Animal Feeding Operations (CAFOs) are not known to operate in either St. Lucie or Martin County.

In 2002, NASS reported 221,537 acres of farmland in St. Lucie County and 206,198 acres of farmland in Martin County.

Table 4. Livestock Inventory by County (source: NASS, 2002)

Livestock (inventory)	Martin
Cattle and calves	27,279
Hogs and Pigs	439

6.5 Onsite Sewerage Treatment and Disposal Systems (Septic Tanks)

Onsite sewage treatment and disposal systems (OSTDs) including septic tanks are commonly used where providing central sewer is not cost effective or practical. When properly sited, designed, constructed, maintained, and operated, OSTDs are a safe means of disposing of domestic waste. The effluent from a well-functioning OSTD is comparable to secondarily treated wastewater from a sewage treatment plant. When not functioning properly, OSTDs can be a source of nutrient (nitrogen and phosphorus), pathogens, and other pollutants to both ground water and surface water. The State of Florida Department of Health (www.doh.state.fl.us/environment/ostds/statistics/ostdsstatistics.htm) publishes septic tanks data on a county basis. Table 5 summarizes the cumulative number of septic systems installed since the 1970 census. The data does not reflect septic tanks removed from service.

Table 5. County Estimates of Septic Tank Installations (FDEP, 2004)

County	Number Septic Tanks (1970- 2002)
Martin	27,284

6.6 Urban Development

Fecal coliform loading from urban areas is attributable to multiple sources including storm-water runoff, leaks and overflows from sanitary sewer systems, illicit discharges of sanitary waste, runoff from improper disposal of waste materials, leaking septic systems, and domestic animals.

In 1982, Florida became the first state in the country to implement statewide regulations to address the issue of non-point source pollution by requiring new development and redevelopment to treat storm-water before it is discharged. The Stormwater Rule, as outlined in Chapter 403 Florida Statutes (F.S.), was established as a technology-based program that relies upon the implementation of BMPs that are designed to achieve a specific level of treatment (i.e., performance standards) as set forth in Chapter 62-40, F.A.C. Florida's storm-water program is unique in having a performance standard for older storm-water systems that were built before the implementation of the Stormwater Rule in 1982. This rule states: "the pollutant loading from older storm-water management systems shall be reduced as needed to restore or maintain the beneficial uses of water" (Section 62-4-.432 (5) (c), F.A.C.).

Nonstructural and structural BMPs are an integral part of the State's storm-water programs. Nonstructural BMPs, often referred to as "source controls", are those that can be used to prevent the generation of NPS pollutants or to limit their transport off-site. Typical nonstructural BMPs include public education, land use management, preservation of wetlands and floodplains, and minimizing impervious surfaces. Technology-based structural BMPs are used to mitigate the increased storm-water peak discharge rate, volume, and pollutant loadings that accompany urbanization.

7. Analytical Approach

The approach for calculating coliform TMDLs depends on the number of water quality samples and the availability of flow data. When long-term records of water quality and flow data are not available, the TMDL is expressed as a percent reduction. Load duration curves are used to develop TMDLs when significant data are available to develop a relationship between flow and concentration. Load duration curves utilize a mass balance approach to estimate loadings transported in the stream. For the load duration curve TMDLs, the target is the acute criteria. Since only 5 water quality measurements were available, this fecal coliform TMDL is expressed as a percent reduction.

7.1 Percent Reduction Approach for TMDL Development

Under this "percent reduction" method, the percent reduction needed to meet the applicable criterion is calculated based on a percentile of all measured concentrations. The (p X 100) percentile is the value with the cumulative probability of p. For example, the 90^{th} percentile has a cumulative probability of 0.90. The 90^{th} percentile is also called the 10 percent exceedance event because it will be exceeded with the probability of 0.10. Therefore, considering a set of water

quality data, 90 percent of the measured values are lower than the 90th percentile concentration and 10 percent are higher. Since the water quality standard states the fecal coliform concentration shall not exceed 400 in 10 percent of the samples, 400 should be targeted with a percentile slightly larger than 90 to ensure less than 10 percent of the values exceed 400. A 95th percentile of 400 counts per 100 ml was initially selected as the target for this TMDL. This would meet the water quality standard and provide a margin of safety by ensuring that only 5 percent of the data exceed a concentration of 400. However, for this TMDL, a 95th percentile could not be calculated without extrapolation beyond to observed data since there were only 5 measurements (see Appendix B). Therefore 400 counts per 100 milliliter was targeted as a maximum. The TMDL percent reduction required to meet the coliform criteria is based on the following equation:

Percent Reduction = (maximum measured concentration – 400) / maximum measured concentration × 100 (Equation 1)

In WBID 3211 the maximum concentration is 650 MPN/100ml, and a 38 percent reduction is necessary to meet the water quality target of 400 MPN/100 ml all of the time.

8. Development of Total Maximum Daily Loads

The TMDL process quantifies the amount of a pollutant that can be assimilated in a waterbody, identifies the sources of the pollutant, and recommends regulatory or other actions to be taken to achieve compliance with applicable water quality standards based on the relationship between pollution sources and in-stream water quality conditions. A TMDL can be expressed as the sum of all point source loads (Waste Load Allocations), non-point source loads (Load Allocations), and an appropriate margin of safety (MOS), which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$TMDL = \Sigma WLAs + \Sigma LAs + MOS$$

The objective of a TMDL is to allocate loads among all of the known pollutant sources throughout a watershed so that appropriate control measures can be implemented and water quality standards achieved. 40 CFR §130.2 (i) states that TMDLs can be expressed in terms of mass per time (e.g. pounds per day), toxicity, or other appropriate measures. The TMDL for the Bessey Creek WBID is expressed as a percent reduction.

8.1 Critical Conditions

The critical condition for non-point source coliform loading is an extended dry period followed by a rainfall runoff event. During the dry weather period, coliforms build up on the land surface, and are washed off by rainfall. The critical condition for point source loading occurs during periods of low stream flow when dilution is minimized. Water quality data have been collected

during both time periods. Most violations occur during median to high flow conditions. Critical conditions are accounted for in the analyses by using the entire period of record of measured flows (when available) and all water quality data available for the WBID.

8.2 Margin of Safety

TMDLs shall include a margin of safety that takes into account any lack of knowledge about the pollutant loading and in-stream water quality. In this case the measured water quality was used directly to determine the reduction to meet the water quality standard. In this case the lack of knowledge concerns the data, and how well it represents the true water quality. There are two methods for incorporating a MOS in the analysis: 1) implicitly incorporate the MOS using conservative model assumptions to develop allocations; or 2) explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations. In the Bessey Creek WBID TMDL, an implicit MOS was used by targeting a maximum concentration of 400 counts per 100 ml even though the standard permits some exceedance of 400, and requires a maximum concentration of 800.

8.3 Determination of TMDL, LA and WLA

The TMDL values represent the maximum daily load the stream can assimilate and maintain water quality standards. The TMDLs are based on not exceeding 400 and are expressed in units of MPN per day. TMDL components for the impaired water-bodies required to achieve the numerical criterion are summarized in Table 6.

Table 6. Summary of TMDL Components

Stream Name / WBID	Parameter	WLA		LA	TMDL
		FL0043214	MS4		
Bessey Creek (3211)	Fecal Coliform	38% reduction	38% reduction	38% reduction	38% reduction

8.4 Waste Load Allocations

The waste load allocation for municipal separated storm sewer systems and the intermittent Martin County Utilities (MCU) Consolidated Reuse System (South County) discharge is 38 percent reduction from existing loads.

8.5 Load Allocations

There are two modes of transport for non-point source coliform bacteria loading into the stream. First, fecal coliform loading from failing septic systems and animals in the stream are considered direct sources of coliform to the stream, since they are independent of precipitation. The second mode involves coliform loadings resulting from accumulation on land surfaces transported to

streams during storm events. All five of the measurements in the Bessey Creek WBID were on 1/27/1992, and were taken from different water quality monitoring stations. There was no rain recorded on that day at NOAA's St. Lucie New Lock station, and the last measured rainfall event was 0.17 inches on 1/19/1992 through 1/20/1992. Thus, according to this data, the load allocation of 38 percent reduction should target direct sources since the violations are independent of rainfall events.

8.6 Seasonal Variation

Seasonal variation was not evaluated because the only available water quality data associated with the impaired WBIDs was collected on a single day.

8.7 Recommendations

Determining the source of bacteria in waterbodies is the initial step to implementing a coliform TMDL. FDEP employs the Basin Management Action Plan (B-MAP) as the mechanism for developing strategies to accomplish the necessary load reductions. Components of a B-MAP are:

- Allocations among stakeholders
- Listing of specific activities to achieve reductions
- Project initiation and completion timeliness
- Identification of funding opportunities
- Agreements
- Local ordinances
- Local water quality standards and permits
- Follow-up monitoring

9. REFERENCES

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APPENDIX A: Water Quality Remark Codes

Table 7: Guide to Water Quality Remark Codes (Rcode column in data tables)

Remark Code	Definition	Use in TMDL
A	Value reported is mean of two or more samples	Data included in analysis as reported
B	Result based on colony counts outside the acceptable range	Data included in analysis as reported
E	Extra sample taken in compositing process	Data included as average
I	The value reported is less than the practical quantification limit and greater than or equal to the method detection limit.	Data included in analysis as reported
J	Estimated. Value shown is not a result of analytical measurement.	Data included in analysis as reported
K	Off-scale low. Actual value not known, but known to be less than value shown	Data included in analysis as reported
L	Off-scale high. Actual value not known, but known to be greater than value shown	Data included in analysis as reported
Q	Sample held beyond normal holding time	Data used in analysis – holding samples on ice slows the metabolism of the organisms resulting in no appreciable growth. Actual concentration is expected to be at least as high as the value reported.
T	Value reported is less than the criteria of detection	Data included in analysis if the reported value is below criteria; otherwise, reported value is not used in the analysis
U	Material was analyzed for but not detected. Value stored is the limit of detection.	Data not included in analysis
<	NAWQA – actual value is known to be less than the value shown	Data included in analysis
Z	Too many colonies were present to count (TNTC), the numeric value represents the filtration volume	Data not included in analysis

APPENDIX B: Water Quality Data and Percentile Calculations

Date	Time	Station	Result	Rank	Percentile by Hazen method
1/27/1992	1045	21FLA 28010031	10	1	10%
1/27/1992	1120	21FLA 28010098	75	2	30%
1/27/1992	1145	21FLA 28010176	80	3	50%
1/27/1992	1315	21FLA 28010213	420	4	70%
1/27/1992	1250	21FLA 28010047	650	5	90%

There are many formula for determining the percentile and these can be found in many text books on statistics. In this TMDL the Hazen formula was used since it is recommended in Hunter's Applied Microbiology (2002) article concerning bacteria in water.